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THE EFFECT OF DOPED FUELS ON THE FUEL SYSTEM

PART II

(MATERIAL SECTION REPORT No. 173)

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PART II.

GENERAL.

Reference is made to a previous report (Air Service Information Circular, Vol. IV, No. 308) by the Material Section, Engineering Division, Air Service, with the same title, dated September, 1921, in which the following conclusions were drawn:

It is found—

(*a*) That the following metals are very slightly, if at all, affected by doped fuels:

Aluminum.	Zinc.

(*b*) That the following materials were very badly affected by such fuels:

Copper.	Terneplate.
Brass.	Iron.

(*c*) That tin plate is moderately attacked by those fuels.

(*d*) It is expected, therefore, that considerable difficulty will be experienced with terneplate tanks, copper lines, brass jets, liners, etc., while aluminum and zinc would overcome this difficulty to a great extent.

The above report covered some of the materials of interest in connection with the effect of doped fuels on the materials in the fuel system. Further data have been included herein according to the suggestion of the Power Plant Laboratory.

PURPOSE.

The purpose of this investigation was to give a more complete idea of the corrosive effect of various doped fuels on materials used or proposed for use in the fuel systems.

CONCLUSIONS.

Conclusions were first drawn on the effect of the various fuels without the addition of a small amount of water to the fuels.

It is found—

(*a*) That the following materials are very slightly, if at all, affected by doped fuels:

Armco iron.	Zinc.
Duralumin.	Tin.
Aluminum.	Red fiber.

(*b*) That the following materials are very badly affected by such fuels:

Lead-clad.	Cork.
Copper.	Vellum.
Brass.	Iron.

(*c*) That the following materials are only slightly affected by these fuels:

Leather.	Monel metal.
Textoil.	

In order to simulate more closely the conditions in the fuel system, a small amount of water was added to the fuels which changed the order of the foregoing conclusions as follows:

Red fiber, Tin	Very slightly, if at all, affected.
Aluminum, Duralumin, Monel, Textoil, Leather	Slightly affected.
Cork, Copper, Brass, Iron, Zinc, Armco, Vellum, Lead-clad	Badly affected.

MATERIAL.

The materials used in this investigation were determined by the Power Plant Laboratory, fuel systems branch. Lead-clad was added to the list in order to compare it with those suggested.

As far as possible, all materials were obtained in sheet form and cut into strips ½ inch wide and 4 inches long. These were partly immersed in the fuels in stoppered bottles.

The following materials were tested with the monoethylaniline 7 per cent plus aviation gasoline 93 per cent solution:

Cork.	Lead-clad.
Duralumin.	Copper.
Textoil.	Brass.
Vellum.	Tin plate.
Monel metal.	Zinc plate.
Leather.	Aluminum.
Red fiber.	Steel.
Armco.	

The following materials were exposed to the action of aviation gasoline alone, 50-50 per cent gasoline-benzol mixture, 91-9 per cent gasoline-antiknock No. 1, and 93-7 per cent gasoline-monoethylaniline:

Lead-clad.	Leather.
Red fiber.	Vellum.
Monel metal.	Duralumin.
Textoil.	Cork.
Armco.	

The aviation gasoline (fig. 1) and benzol were obtained from stock at McCook Field. The doped fuels were furnished by the Power Plant Laboratory, from the General Motors Corporation, research division, at Moraine City.

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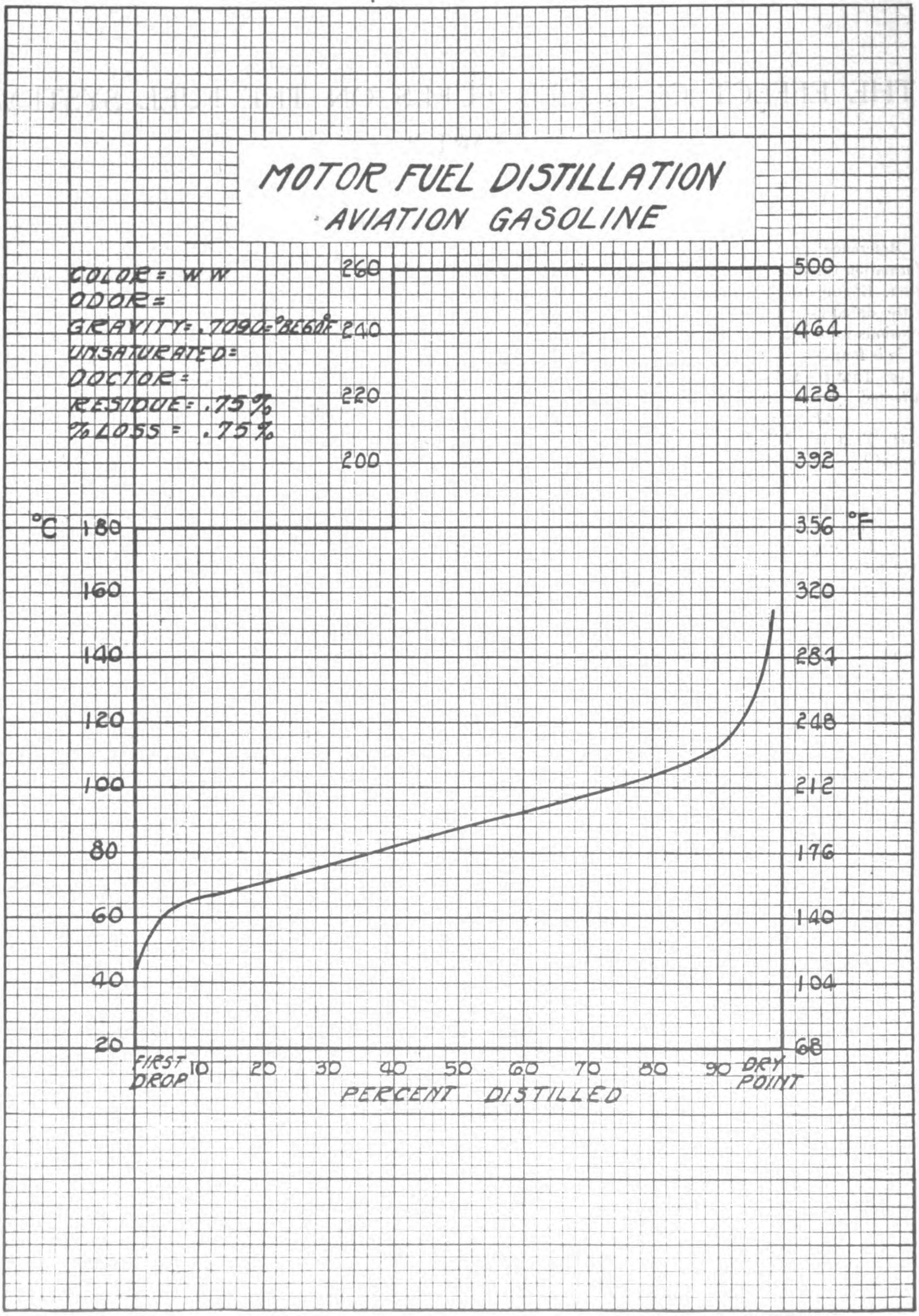
MOTOR FUEL DISTILLATION
AVIATION GASOLINE
COLOR = W.W
ODOR =
GRAVITY = .7090 = °BE 60°F
UNSATURATED =
DOCTOR =
RESIDUE = .75%
% LOSS = .75%
°C
260
240
220
200
180
160
140
120
100
80
60
40
20
°F
500
464
428
392
356
320
284
248
212
176
140
104
68
FIRST DROP
10
20
30
40
50
60
70
80
90
DRY POINT
PERCENT DISTILLED

Fig. 1.

METHOD OF PROCEDURE.

In all cases the materials were cut into strips ½ inch wide and 4 inches long, the thickness varying according to that obtainable in stock. These were placed in the above fuels in such a manner that only half of the specimen was immersed in the liquid, the other half being exposed to atmosphere saturated with the vapors of each fuel. The flasks were securely stoppered so as to exclude the possibilities of ventilation or evaporation, thereby simulating very closely a partially filled gasoline tank. After such data had been obtained from these exposures, 25 c. c. of distilled water was added and the materials again exposed.

RESULTS.

The results obtained from the water-free exposures are shown in Table No. 1.

DISCUSSION OF RESULTS.

In Table No. 1 materials are listed in accordance with the amount of corrosion or deterioration shown. Those at the top of the list were least affected, while those at the bottom were badly affected. This arrangement was brought about by noting the color changes on the specimen above and below the surface of the fuel, by the amount of sediment formed on the bottom of the container, and by simple tests on the strength and elasticity, as in the case of cork, leather, and vellum.

The fact that Textoil does not hold its place among the best materials is due only to the fact that a small amount of sediment was noted in each case. This might have been because it was necessary to expose so much of the raw edges; visibly no discoloration was evidenced. For this reason it is thought that if it could be used where raw edges do not come in contact with the fuels it will stand up well.

As stated in the conclusions, Armco iron shows no signs of corrosion in the fuel alone or in the presence of water when an amine dope is used, but when this class of dope is not added a rapid and excessive formation of ferric hydroxide is noted. The unexpected effect of the amine doped fuels in that it prevented the corrosive effect of the water is explained as follows:

Since the amines are derivatives of ammonia and their properties are somewhat similar it might be expected that the highly ionized carbonic acid in the water would be neutralized by them, thereby preventing the following reactions:

$$Fe+H_2CO_3 \rightarrow FeCO_3+2H$$
$$FeCO_3+H_2O \rightarrow Fe(OH)_2+CO_2$$

Since Armco is so badly affected by water in ordinary fuels, and since water generally finds its way into the various parts of the fuel system, it must lose its place among the least affected materials.

Vellum does not appear to lose its toughness in the fuels, but the doped fuels stained it badly. Water present, however, destroys the toughness of this material.

Lead-clad and alloys containing lead to any extent seem to be greatly affected by all the fuels used in the tests.

Zinc likewise drops to the position of the badly affected materials when immersed in water.

TABLE No. 1.

Material.	Days exposure.	High-test gasoline.	9 per cent antiknock and 91 per cent high-test gasoline.	7 per cent monoethylaniline and 93 per cent high-test gasoline.	50 per cent benzol and 50 per cent high-test gasoline.
Armco	47	O. K.	O. K.	O. K.	O. K.
	78	O. K.	O. K.	O. K.	O. K.
	104	O. K.	O. K.	O. K.	O. K.
Duralumin	47	O. K.	O. K.	O. K.	O. K.
	78	O. K.	O. K.	O. K.	O. K.
	104	O. K.	O. K.	O. K.	O. K.
Aluminum	47			O. K.	
	78			O. K.	
	104			O. K.	
Zinc	47			O. K.	
	78			O. K.	
	104			O. K.	
Tin	47			O. K.	
	78			O. K.	
	104			O. K.	
Red fiber	47	O. K.	O. K.	O. K.	O. K.
	78	O. K.	O. K.	O. K.	O. K.
	104	O. K.	O. K.	O. K.	O. K.
Leather	47	O. K.	O. K.	Slight stain	O. K.
	78	O. K.	Slight stain	do.	O. K.
	104	O. K.	do.	do.	Slight stain.
Textoil	47	O. K.	O. K.	O. K.	O. K.
	78	Slight disintegration	Slight disintegration	Slight disintegration	Slight disintegration.
	104	do.	do.	do.	Do.
Monel	47	O. K.	Slight deposit	Slight deposit	O. K.
	78	O. K.	do.	do.	O. K.
	104	O. K.	do.	do.	O. K.
Iron	47			do.	
	78			Deposit	
	104			do.	
Vellum	47	O. K.	Badly stained	Stained	O. K.
	78	O. K.	do.	Badly stained	O. K.
	104	O. K.	do.	do.	O. K.
Cork	47	O. K.	Slight stain	O. K.	Stained.
	78	O. K.	do.	Slight stain	Do.
	104	O. K.	Stained	do.	Disintegrated.
Brass	47			Deposit	
	78			do.	
	104			do.	
Copper	47			do.	
	78			do.	
	104			do.	
Lead-clad	47	Stained	Stained	Slight stain	Slight stain.
	78	Disintegrated	Disintegrated	Disintegrated	Disintegrated.
	104	do.	do.	do.	Do.